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ARMY TECHNICAL INTELLIGENCE REVIEW

SUPPLEMENT - JULY 1973

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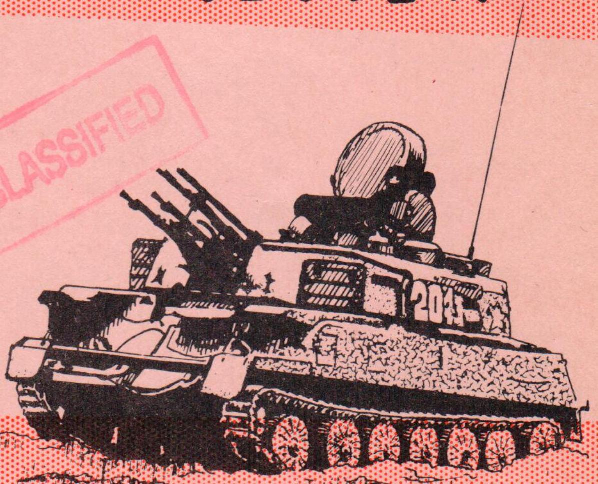

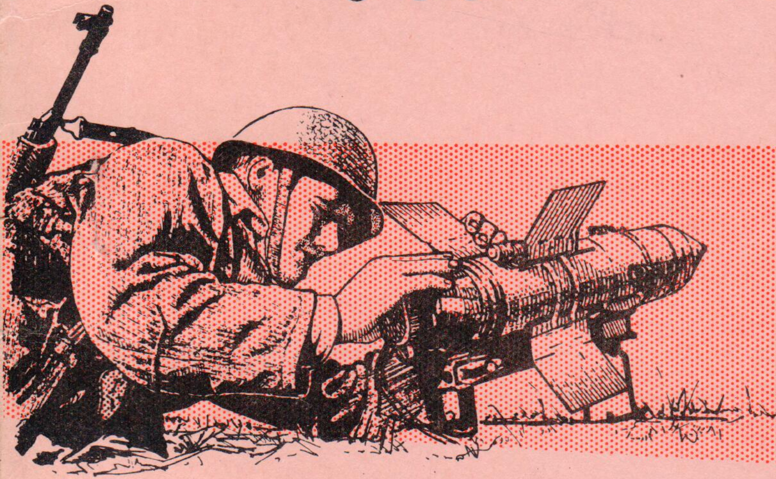

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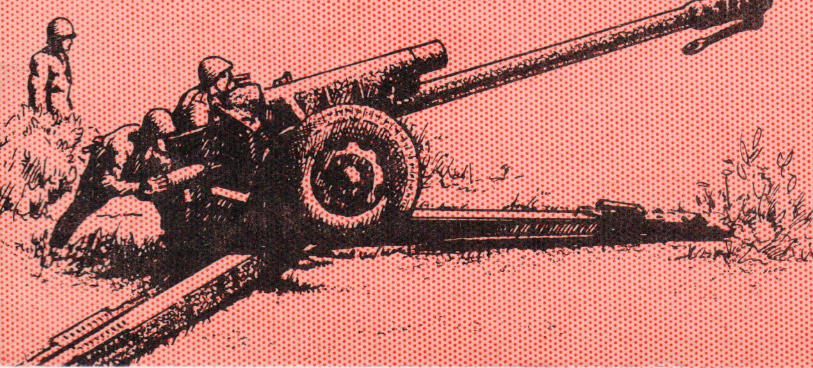

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ARMY TECHNICAL INTELLIGENCE REVIEW No 103 (SECRET)

SUPPLEMENT JULY 1973

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ARMY TECHNICAL INTELLIGENCE REVIEW No 103 (SECRET)

SUPPLEMENT JULY 1973

FOREWORD

I had hoped to include the second part of the article on Chinese AFVs in this edition of the review. Owing to unexpected staff changes this has proved to be impossible but it is now firmly planned for the next edition.

In spite of this there is much of topical interest in this issue. The articles on the Czech 122 mm Rocket Launcher M-1972? and the BRDM mounted version of SA-7 are, I believe, particularly timely. It is perhaps worth stressing however that the rocket launcher has only been seen demonstrated during the course of one exercise and that there is as yet no evidence of it being even in limited service with the Czech forces, let alone in use by any other Warsaw Pact countries.

W A H FAIRBAIRN
Colonel
Tech Int (A)

1. CZECH 122mm ‹40Rd› RL M1972? (SECRET)

This new Czechoslovak 122 mm rocket launcher was first seen on the final parade of Exercise Shield 72 in Prague on 16 Sept 72. It is mounted on the Czechoslovak TATRA 813 which as can be seen in Fig 1 appears to have been modified, having an armoured cab and possibly other strengthening modifications. The rocket launcher appears to be the same as the Soviet BM-21 and so probably has the same performance but what is significant about this weapon system is the spare salvo carried on each TATRA 813.

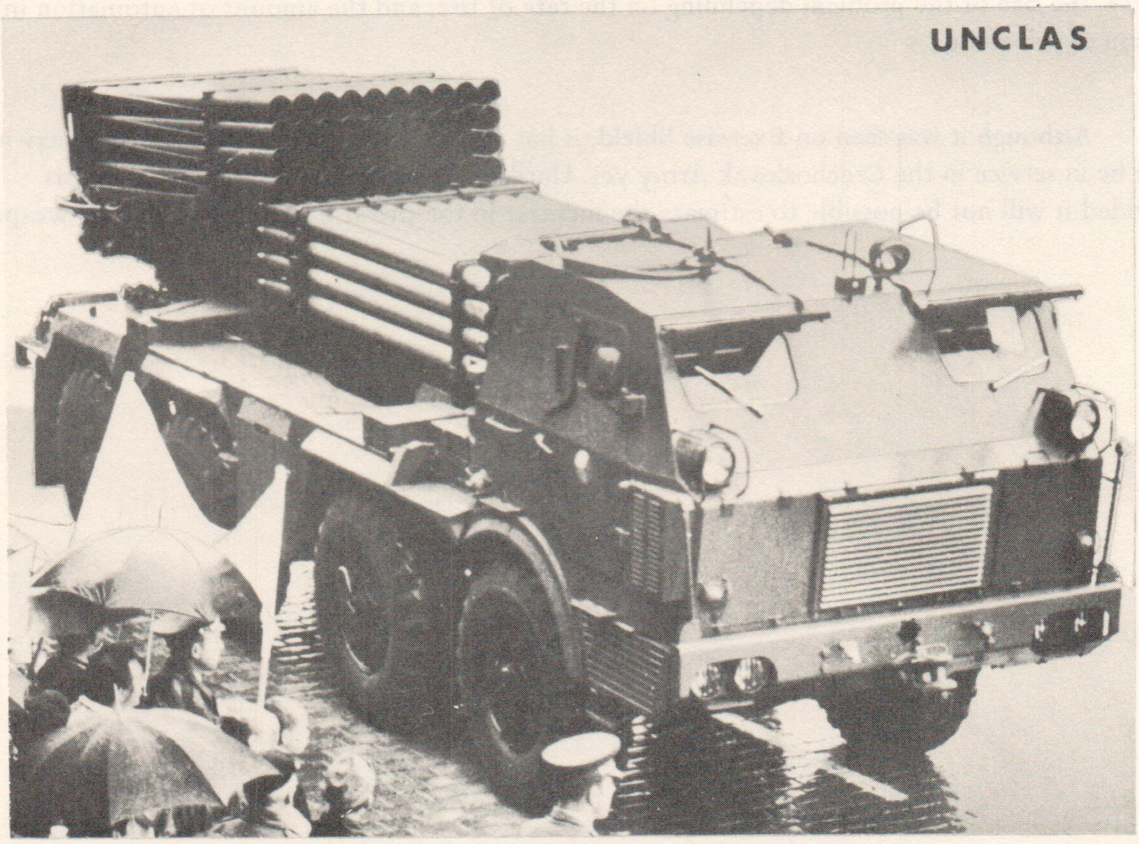

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Fig 1. Czech 122 mm RL M-1972?

We have since seen a film showing that the spare salvo can be loaded automatically as one. We know that this is done by turning the tubes through 180° so that the base of them face the front of the vehicle. The spare salvo then moves towards the tubes with the rockets being lifted into line and moved into the tubes as a continuous movement guided by the framework, parts of which move with the rockets. The rockets are pushed home into the tubes by what appear to be plungers on the base of the framework. When this has been completed the whole framework is withdrawn. The actual loading of the rockets takes only 25 seconds against the BM-21 reloading time by hand of 10–15 minutes. The whole demonstration of the loading of the spare salvo including the turning of the tubes by the layer in what appears to be slow motion only takes one minute.

This new Czech rocket launcher increases the threat of the number of rounds which can be fired in a short time. BM-21 can fire 40 rounds in as short a time as 20 seconds, but takes 10 to 15 minutes to reload and fire a second salvo, whereas the Czech rocket launcher may be able to fire two salvos in less than 2 minutes.

We do not know yet if the spare salvo is palletized which would be logical and would seem most attractive, but of course this would give the launcher a much greater logistical problem than BM-21, the size of the problem depending on the rate of fire, and the amount of automation in the system of reloading.

Although it was seen on Exercise Shield, it has not been seen in any quantity and may not even be in service in the Czechoslovak Army yet. Until we know the level of logistic support provided it will not be possible to estimate the increase in the threat imposed by this new weapon.

2. SM-70 EAST GERMAN DIRECTIONAL FRAGMENTATION MINE (CONFIDENTIAL)

In recent months press articles have referred to automatic death traps which the East Germans have placed along their border with West Germany. This is in fact a new anti-personnel mine system which the East Germans began installing during 1971. The main component of this system is a directional fragmentation mine called SM-70. The system is reputed to have been developed for the East Germans in Czechoslovakia under the code name RATTE (RAT).

The mine is funnel shaped with a diameter of 80 mm and a length of 150 mm. (Fig 1). The cone material contains a large number of steel fragments which are projected out to a range of approximately 20 m when the mine is detonated. Each mine is fixed to a tubular steel support which is secured to the steel mesh fence concrete supporting posts. The mine is activated by a pull-release firing device which is located directly beneath it and which is connected to it by a length of detonating cord. A trip wire 20–25 m long which is under tension runs horizontally from the firing device along the wall to the support for the next mine. Parallel to this wire are safety wires which protect the mechanism from being detonated by birds or small animals. Fig 2 shows three rows of mines along the eastern side of the fence. Signal wires run from each mine to a central control station. When a mine is detonated a bell rings and at the same time a lamp on a control panel indicates the location of the mine. There is some indication that the mines can be activated or deactivated from the control station.

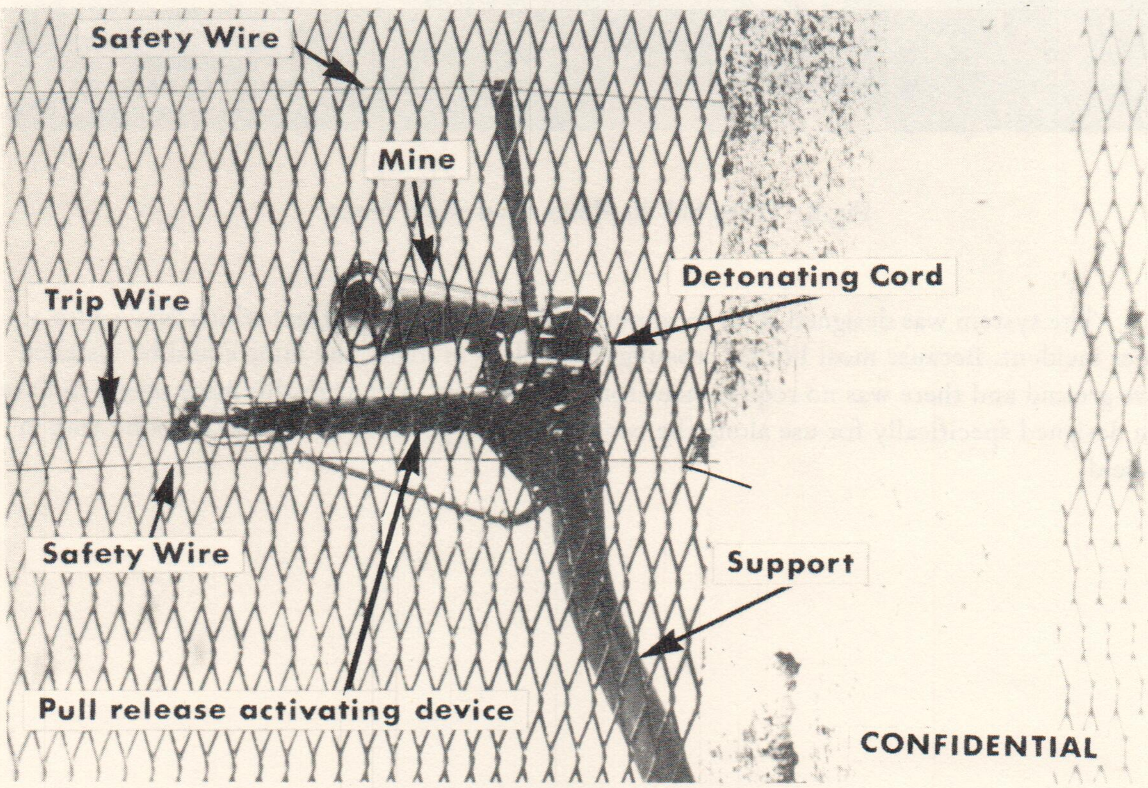

Fig 1. East German Anti-Personnel Mine SM-70

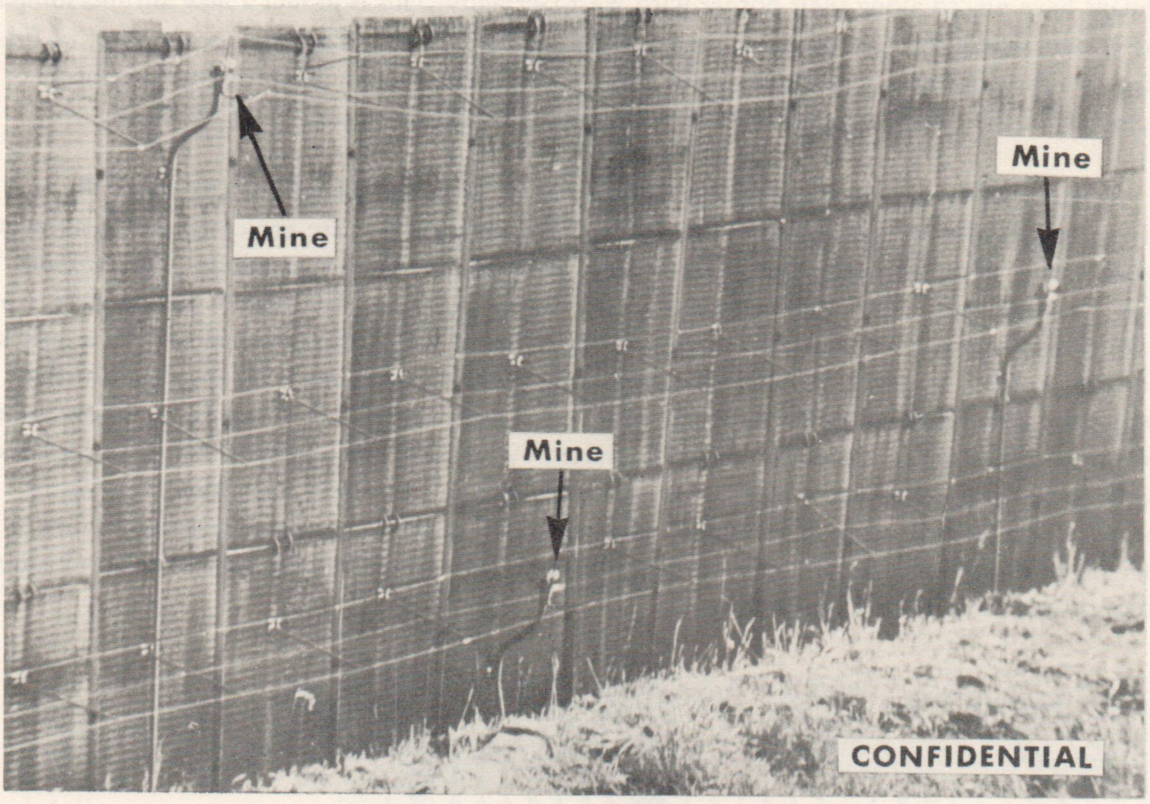

Fig 2. Three SM-70 Mines sited along fence

The system was designed so as to minimise the side-bursting effect which may cause a border incident. Because most border crossings take place at night, the mine could be installed above ground and there was no requirement for concealment. Although this mine seems to have been designed specifically for use along the border it could possibly be used as a booby trap in the field.

3. SOVIET OVERSNOW VEHICLES (SECRET)

The Requirement for Oversnow Vehicles in USSR

Why does the USSR need oversnow vehicles? The answer to this question is evident when studying a map of the world, since a very large proportion of the Soviet Union lies to the north of the 50th parallel and, with its central continental climate, suffers winters of extreme cold and prodigious snowfall. The population of these areas need to be able to travel in these conditions, hence the development of such time-honoured modes of oversnow transportation as snow-shoes, skis and the animal drawn sleigh or sled.

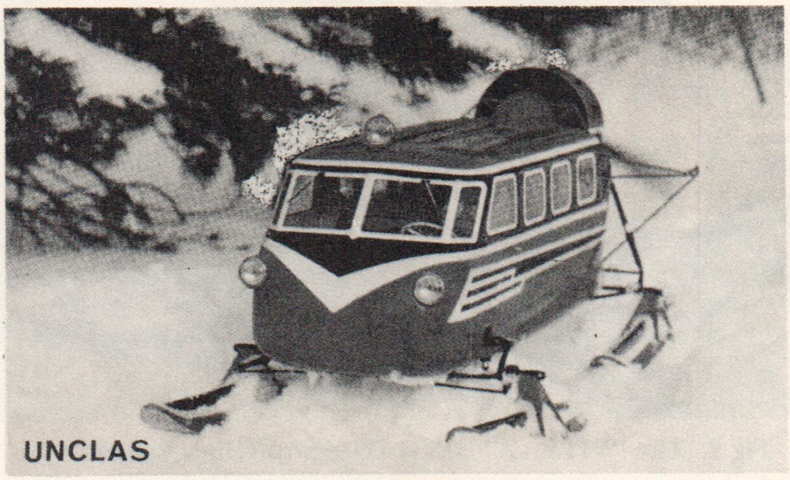

Fig 1. The Ka-30 Aerosled in action in an Oversnow Role

In this modern age, it is only natural that the internal combustion engine should have been considered as an alternative to animals as a means of propulsion for these oversnow "transporters" and so we have seen, in the Soviet Union, the development of a range of specialist oversnow vehicles, such as the Aerosled (Fig 1), as well as track-laying vehicles with a very low ground pressure which are as mobile and manoeuvrable in conditions of deep snow, as they are over less yielding surfaces.

Oversnow Vehicles in the Army

Humiliation at the hands of the Finns during the bitter winter of 1939/40 taught the Soviet Army a never to be forgotten lesson about winter warfare. That lesson has been well learned and, since that time, the army has shown repeatedly its ability to fight effectively and with spirit despite heavy snow and extremely low temperatures. Today's Soviet Army is, in fact, a well-trained well-equipped force capable of sustained operations in Arctic type conditions.

The problems of conducting operations under such conditions are easily defined. In addition to the effects on the men of the extreme cold, deep drifting snow seriously impedes progress both on and off roads. Movement of even a few metres from cleared areas becomes impossible without the aid of specialist oversnow equipment. The Soviet soldier trained for winter warfare holds snow-shoes and skis as basic parts of his equipment and is also fully aware of the oversnow mobility of the animal drawn sleigh, but, in addition to these simple aids, Russian engineers have designed and developed for their army a range of specialist, power-driven oversnow vehicles second to none, and are in the process of developing others. It is to these vehicles and equipments, and to the future trends in the design and development of such equipments for the Soviet Army, that the subsequent paragraphs are devoted.

"Vityaz" (V-1)

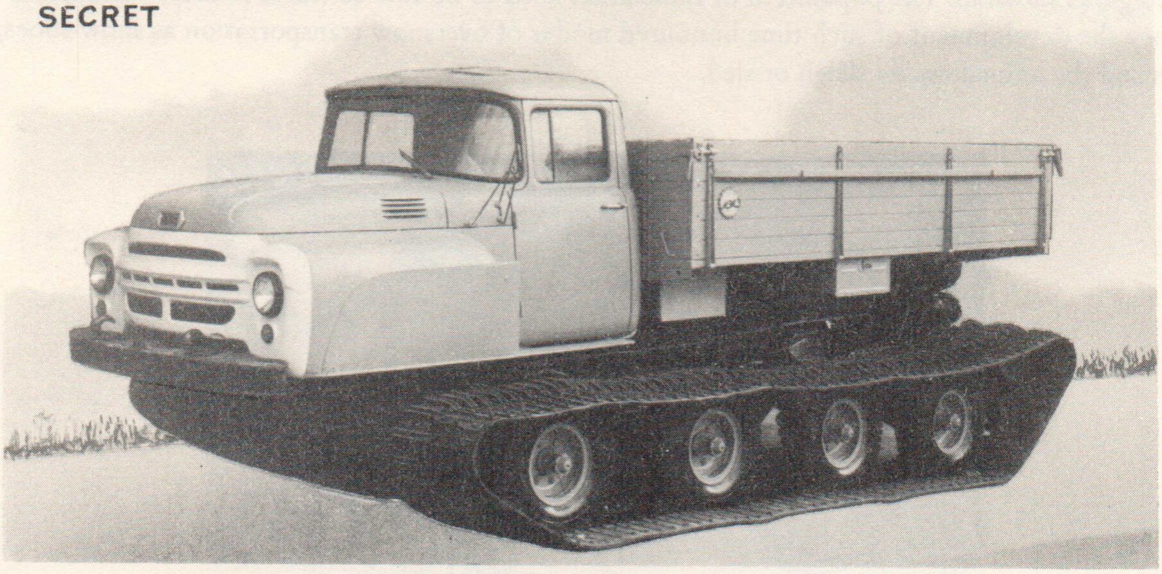

Fig 2. The "VITYAZ" or V-1 Oversnow Cargo Vehicle

The "Vityaz" (Fig 2) is a specialist tracked oversnow vehicle developed on the chassis of the Soviet ZIL-130 truck. Although designed primarily to meet civilian transportation requirements in conditions of heavy snow the vehicle has distinct military potential as a personnel and cargo carrier and could be in limited service with the Soviet Army. It has broad metal and rubber fabricated tracks, each just under 1 metre in width and, even fully laden it has an extremely low ground pressure. Brief technical characteristics are as follows:

Kerb Weight:	4200 kg
Maximum Payload:	3000 kg
Overall Length:	6.72 m
Overall Width:	3.17 m
Overall Height:	2.65 m
Track Centre to Centre:	2.25 m
Width of Track:	920 mm
Ground Clearance:	810 mm
Engine Type:	ZIL-130, V8 petrol engine, water cooled
Brake Horse Power:	150 bhp at 3200 rpm
Maximum Speed:	27 kph
Ground Pressure:	0.13 kg/cm^2

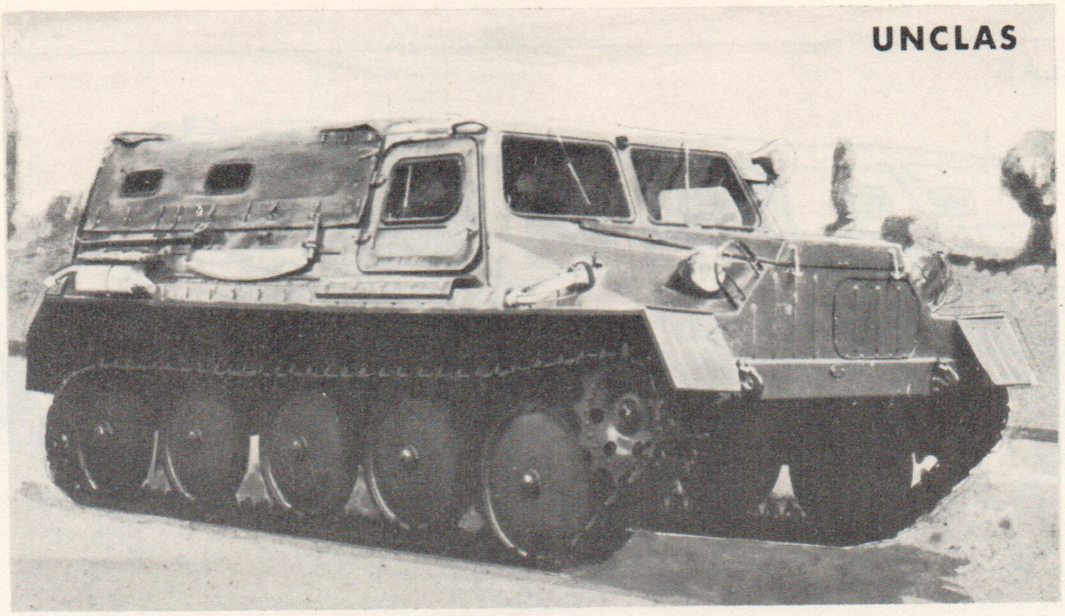

Fig 3. The Medium Tracked Transporter GT-S (GAZ-47)

The most interesting group of oversnow vehicles developed primarily for military use are the vehicles of the Gorkiy manufactured GAZ "GT" range. The first vehicle of this family produced in quantity was the GT-S medium tracked transporter (Fig 3), sometimes known as GAZ-47. First seen in 1956, and now seen only rarely in military service, GT-S is a gun-tractor, personnel and cargo carrier and reconnaissance vehicle employed primarily in the Soviet North and Far East. An engine preheater aids cold weather operations, whilst the suspension is torsion bar and transverse leaf and the drive is from a front sprocket with five rubber tyred road wheels and no idler. GT-S is amphibious and its technical characteristics are as follows:

Kerb Weight:		3650 kg
Maximum Payload:		1000 kg
Overall Length:		4.9 m
Overall Width:		2.43 m
Overall Height:		1.96 m
Track Centre to Centre:		1.05 m
Width of Track:		300 mm
Ground Clearance:		400 mm
Engine Type:		GAZ-47A, 6 cylinder-in-line petrol engine, water cooled.
Brake Horse Power:		85 bhp at 3200 rpm
Maximum Speed:	Road:	35 kph
	Water:	4 kph
Ground Pressure:		0.24 kg/cm^2

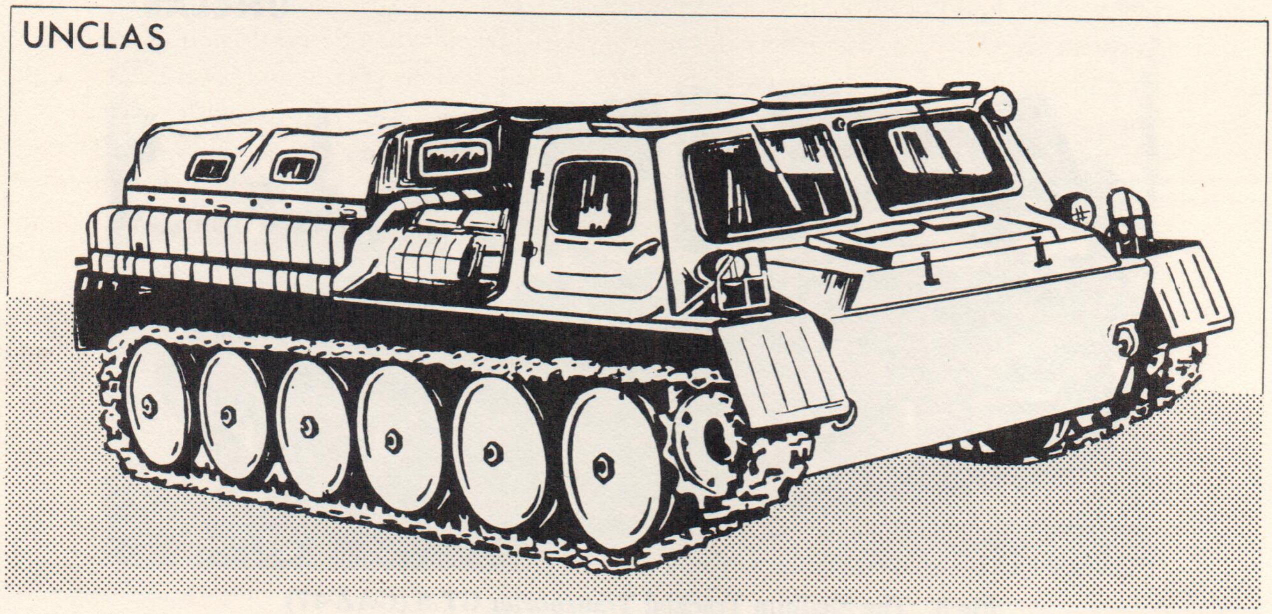

Fig 4. Tracked Personnel and Cargo Carrier GT-SM (GAZ-71)

The Medium Tracked Transporter GT-SM or GAZ-71 (Fig 4) is a considerably modified and updated version of GT-S, which it is apparently replacing in service. First seen in 1970 this vehicle carries a crew of two plus one tonne of cargo or ten passengers. With a ground pressure rather lower than GT-S, and a top speed considerably higher, it is a very high performance oversnow vehicle indeed. It has a separate two seater cab and cargo compartment and is used for carriage of personnel and/or cargo, as a gun tractor and as a reconnaissance vehicle in the Soviet North and Far East. It is amphibious, has independent torsion bar suspension, front sprocket drive with six rubber tyred road wheels the last of which acts as an idler, and has an engine preheater. Briefly its technical characteristics are as follows:

Kerb Weight:		3660–3840 kg
Maximum Payload:		1000 kg
Overall Length:		5.37 m
Overall Width:		2.59 m
Overall Height:		1.74 m
Track Centre to Centre:		2.18 m
Width of Track:		350 mm approx
Ground Clearance:		380 mm
Engine Type:		GAZ-71, V8 petrol engine, water cooled.
Brake Horse Power:		115 bhp at 3200 rpm
Maximum Speed:	Road:	50 kph
	Cross Country:	20 kph
	Water:	5–6 kph
Ground Pressure:		0.17 kg/cm^2

Both GT-S and GT-SM have cab heaters, not a standard feature in Soviet vehicles despite their severe winters, and both have been modified to carry out other specialist functions and to test other drive systems. GT-S for instance has been fitted with Archimedian-Screw drive in place of tracks. This "mobile test bed" is designated the GPI-63 Snow Vehicle (Fig 5) and is very stable and manoeuvrable in snow, ice, swamp, deep sand and even through water. It is fitted with two rust-proof steel cylindrical rotors which are filled with plastic foam and fitted with spiral blades. These cylinders when rotated propel the vehicle forwards backwards or sideways and provide flotation. The GPI-63, of which some 20 had been produced up to 1968, can turn in its own length and climb steep slopes although it is unlikely to break any land speed records having a maximum speed of about 18 kph (12 kph in water).

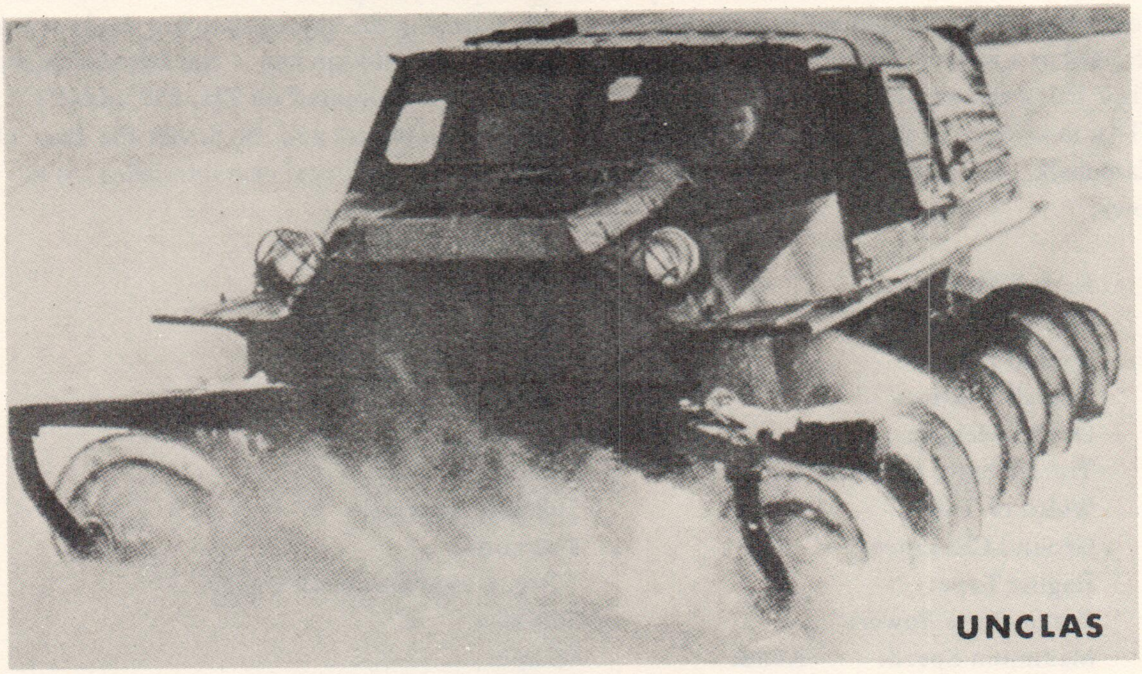

Fig 5. The GPI-63 Snow Vehicle (GT-S based)

GT-SM has been recently seen modified as an amphibious laboratory, its appearance being virtually unchanged from that of the basic vehicle apart from a box-body mounted in place of the conventional cargo compartment. With its inherent oversnow, swamp crossing and amphibious capabilities this should be the ideal carrier of laboratory equipment in remote areas, provided that the equipment is sufficiently robust to withstand the buffeting which it will inevitably receive.

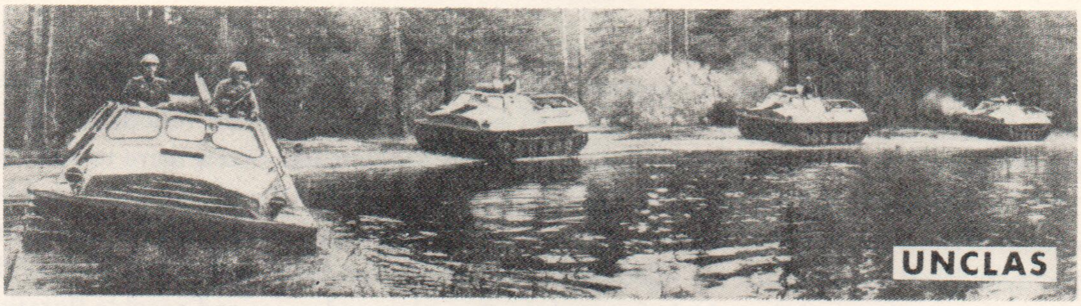

Fig 6. Tracked Transporter GT-T

The third member of the "GT" range is the heavier GT-T Tracked Transporter (Fig 6). This is altogether a larger, heavier vehicle that GT-S and GT-SM and was first seen in 1965. It has a crew of three and can carry ten passengers. In its original version it is used in quite large numbers as a gun-tractor, reconnaissance vehicle, artillery observation post and personnel carrier in the more remote areas of North, Central and Far Eastern USSR. Carrying the appropriate box-body it is, moreover, used as a logistic support vehicle, an ambulance and as a field kitchen – the kitchen shown in Fig 7 being the well-known PAK-200, seen in warmer climes mounted on ZIL-157 and ZIL-131. GT-T is, in effect, the jack-of-all-trades vehicle of the Siberian wastes and the Soviet Far East where, in Kamchalka, it is often photographed for the Soviet Press. Its technical characteristics are as follows:

Kerb Weight:		10200 kg
Maximum Payload:		2000 kg
Overall Length:		6.5 m
Overall Width:		2.8 m
Overall Height:		2 m
Track Centre to Centre:		2.25 m (approx)
Width of Track:		500 mm (approx)
Ground Clearance:		450 mm
Engine Type:		13–6, 6 cylinder diesel engine.
Brake Horse Power:		200 bhp
Maximum Speed:	Road:	45 kph
	Cross Country:	25 kph
	Water:	8 kph
Ground Pressure:		0.24 kg/cm^2

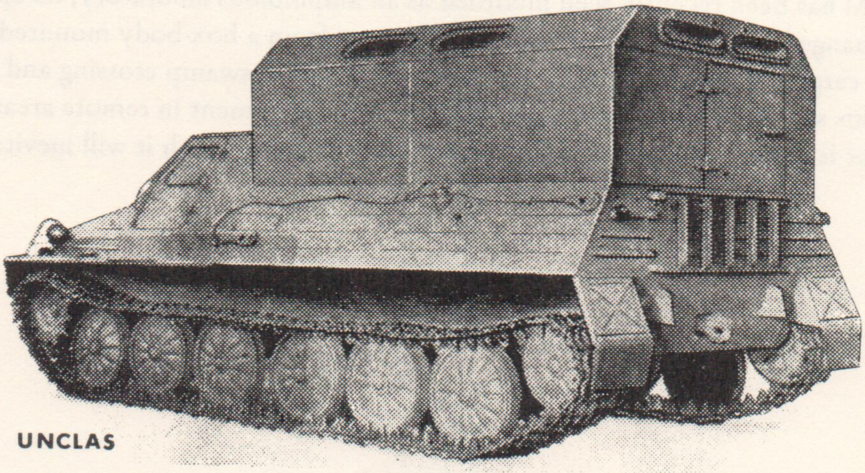

Fig 7. The PAK-200 Field Kitchen version of the GT-T Tracked Oversnow Vehicle

GT-T, like the smaller members of the family, is amphibious and has cab heating. It has front sprocket drive with six rubber tyred road wheels and an idler, and suspension which is very similar to that of the Soviet amphibious tank PT-76.

The influence of GT-T can easily be recognised in the design of the latest additon to the "GT" Oversnow range of vehicles. Tracked Artillery Tractor/APC (M-1970) (Fig 8) was first seen during a Warsaw Pact Exercise in 1970.

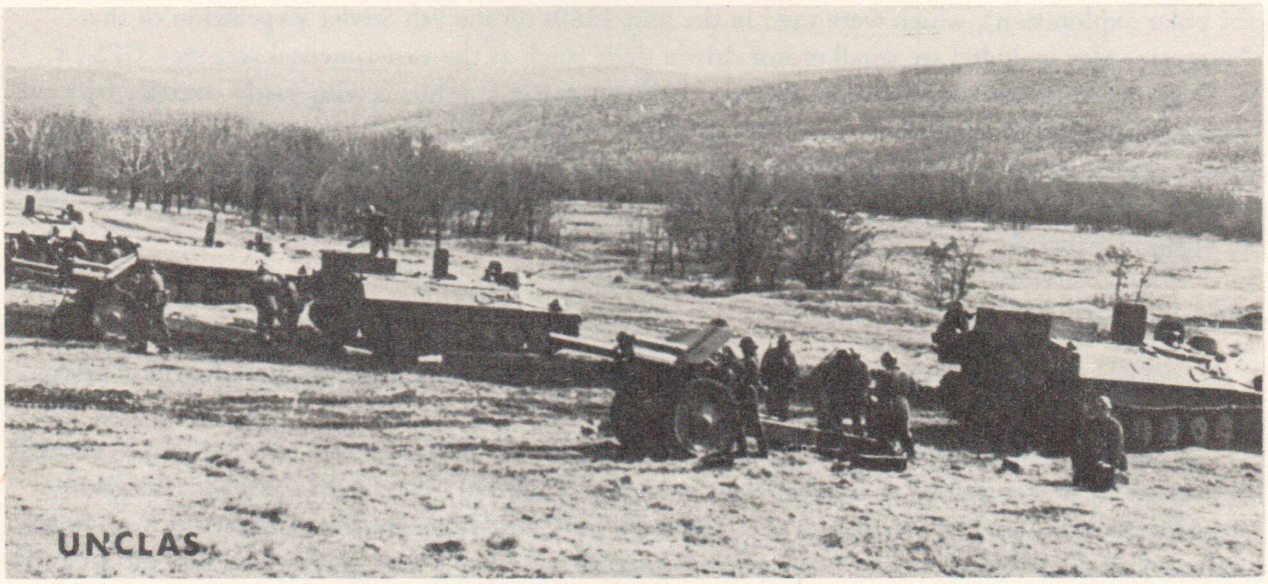

Fig 8. Tracked Artillery Tractor/APC (M-1970) in its Primary Role

With its forward turret-mounted machine gun, of unknown calibre, it is the only specialist oversnow vehicle mounting an armament. It is more heavily armoured than the remainder of the range and there is no evidence that it is amphibious, although its similarity to GT-T would cause one to suspect that it may be so. Although its primary role is that of Artillery Tractor, or would appear to be so, it has been seen recently in the role of an APC in the Northern USSR and may oust GT-T as a personnel carrier in remote areas to the North and Far East of the Soviet Union. The track, suspension and running gear appear to be identical to those of GT-T and one would suspect that the power-pack is also the same. As the vehicle is more heavily armoured, the ground pressure exerted by M-1970 may be a shade higher than that of GT-T, but it would still be an excellent oversnow vehicle. No technical details are held for the vehicle.

Other Oversnow Vehicles

In addition to those military oversnow vehicles already mentioned, which are, or have been, used by the Soviet Army in quite considerable numbers, there are a number of other vehicle types with a more or less effective oversnow capability many of which have a distinct military potential and some of which may, indeed, be in service with the army.

These include two tracked vehicles, "Pinguin" (based on the Soviet light amphibious tank PT-76) and "Kharkhovchanka" (a large oversnow vehicle with metre-wide tracks designed specifically for polar exploration), which were used in the mid-1960s on the 9th Soviet Expedition to the Antarctic. Also included are small motor driven sleds (such as the experimental two-man GPI-18 sled), propeller-driven aerosleds like the Ka-30 shown in Fig 1, vehicles with vastly oversize balloon-tyred wheels giving low ground pressures (URAGAN-8 , an 8 x 8 drive truck with an 8 tonne payload, is an example), semi-tracked vehicles fitted with skids in place of non-driven wheels (UAZ-451S, based on the UAZ-450 series light truck chassis, is a typical example) and vehicles incorporating the air cushion principle.

Future Trends

The present array of Soviet Army oversnow equipment is impressive, but what of the future?

The air cushion principle could hold the key to future developments, not perhaps in straight hovercraft with their inherent disadvantages in an overland role, but utilised to reduce the ground pressure of otherwise conventional tracked vehicles thus combining the best features of both hovercraft and tracked vehicle drives – the effortless mobility and very low ground pressure of the hovercraft and the manoeuvrability, cross-country performance and robustness of the tracked vehicle. Indeed experiments with this type of vehicle are already taking place – ostensibly for use by geologists, postmen and doctors in the Soviet Far North but with an obvious military potential.

The Aerosled may well be introduced into military service in the near future for the transportation of small numbers of men and small quantities of equipment at speed over flattish snow-covered terrain.

The Archimedian-Screw drive already used on GPI-3 (Fig 5) has two serious disadvantages. Vehicles so driven have a very limited top speed and can operate only off roads otherwise they would severely damage the road surface. Nevertheless this type of drive may have some merit for powering oversnow engineer plant.

4. CURRENT SOVIET FREQUENCY MODULATED ‹FM› RADIO SETS (SECRET)

This is the first of a series of articles on Soviet Radio Equipment. It is concerned with the FM radio sets currently employed by the Soviet Armed Forces.

Soviet FM, single channel, communication electronic equipment is either manpack or vehicle mounted. Selected manpack radios can also be employed as vehicle mounted radios. The power output and range of manpack radios, when vehicle mounted, can be increased with an external power amplifier. These radio sets being transceivers can transmit and receive but not simultaneously. The current manpack and vehicle mounted FM radios used by the Soviets are described below.

Manpack FM Radio Sets

R–126

This radio set (see Fig 1) is used primarily at Motor Rifle Company to platoon and Motor Rifle Battalion Special Weapons Nets. The set is normally enclosed in a canvas case with strap, and slung over the shoulder with the radio resting on the operator's side. It has a single earpiece with an attached boom microphone which rests against the operator's cheek. This radio set is compatible with the R–107 manpack radio and the R-123 vehicle mounted radio set. Two other radio sets identical in appearance are known to exist; the 24R-1, a civilian version with a single fixed frequency within the 33-46 MHz range and one having three fixed frequencies.

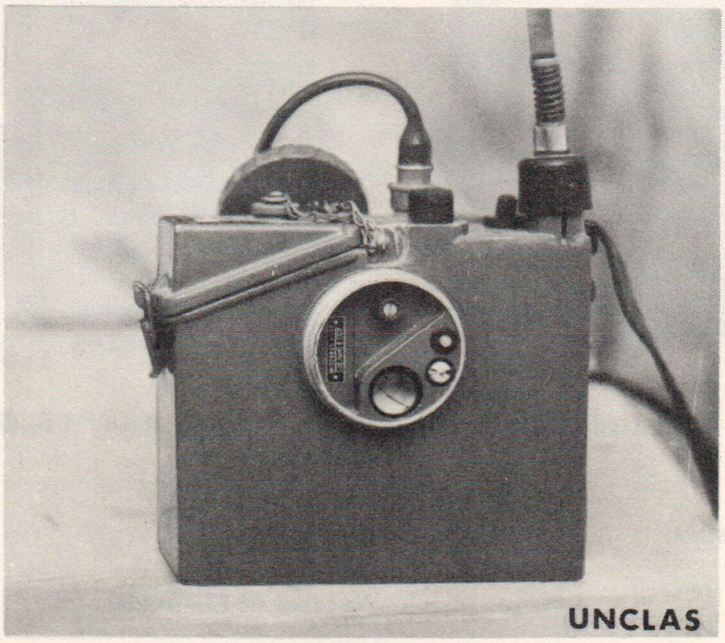

Fig 1. R-126 Manpack FM Radio Set

Technical Characteristics

Frequency Range:	48.5–51.5 MHz	Power Output:	0.75–1.0 Watt
Mode of Operation:	FM Voice (F3)	Power Source:	Silver-Zinc battery
Tuning:	Continuous	Antenna:	Kulikov
Number of RF Channels:	31	How carried:	Manpack

R-105M Family

The R-105M family of FM radio sets is composed of four different radios (R-105M, R-108M, R-109M, R-114M). These radio sets are primarily used at motor rifle company rearwards (R-105M(Fig 2); Artillery from battery rearwards (R-108M); Air defence artillery, Anti-tank and SAM unit nets (R-109M (Fig 3); and the Armoured Secondary net (R-114). The external appearance of these four sets is similar and each cover a portion of the frequency range between 20–46.15 MHz. A 50 KHz overlap into the range of the radio next higher in the frequency range is available to allow for co-ordination between units.

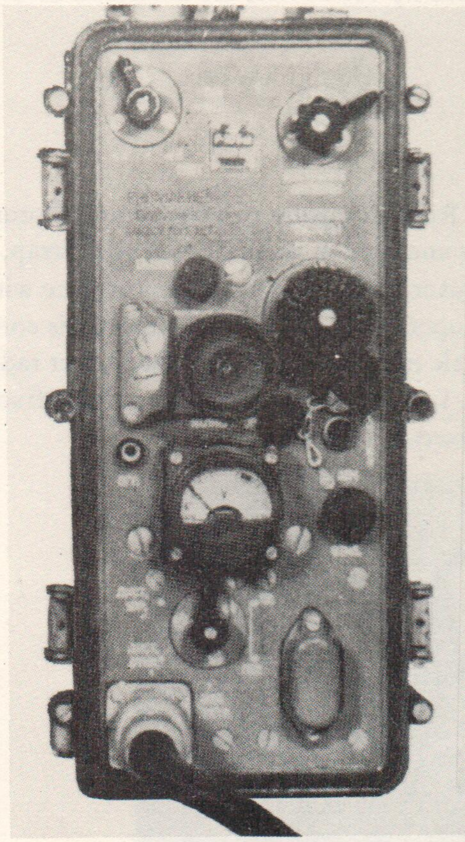

Fig 2. R-105M Radio Set

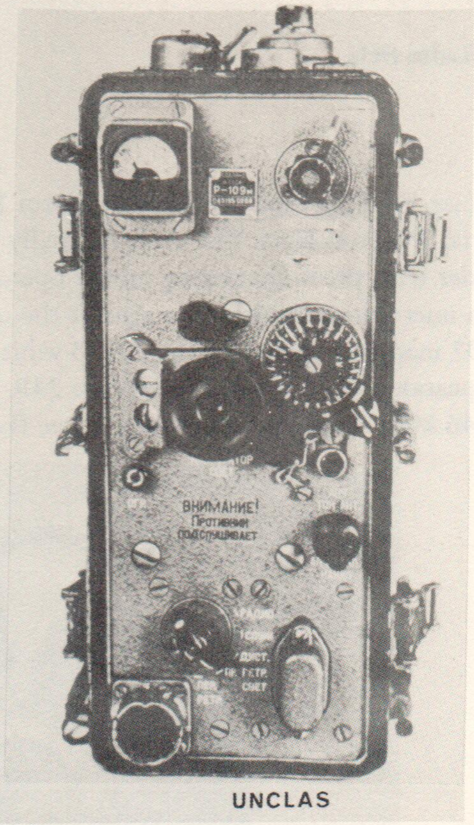

Fig 3. R-109M Radio Set

Technical Characteristics

Frequency Range:		Number of Channels:
R-105M	36.0–46.1 MHz	R-105M–405
R-108M	28.0–36.5 MHz	R-108M–141
R-109M	21.5–28.5 MHz	R-109M–281
R-114M	20.0–26.0 MHz	R-114M–241

Mode of operation:	FM Voice (F-3)	RF Channel Spacing:	25 KHz
Tuning:	Continuous	Power output:	Approx 2 Watts
		Antenna:	Kulikov
		How carried:	Manpack or vehicle

R-107

The R-107 (Fig 4) FM radio set is expected to gradually replace the entire R-105M family of man-pack radios. It has a frequency range of 20.0–52 MHz divided into two frequency bands. This radio is believed to be fully transistorised and have the capability of being operated from a remote position. As with the R-105M family, an auxiliary amplifier unit can probably be connected to this set to increase the power output and extend the effective range.

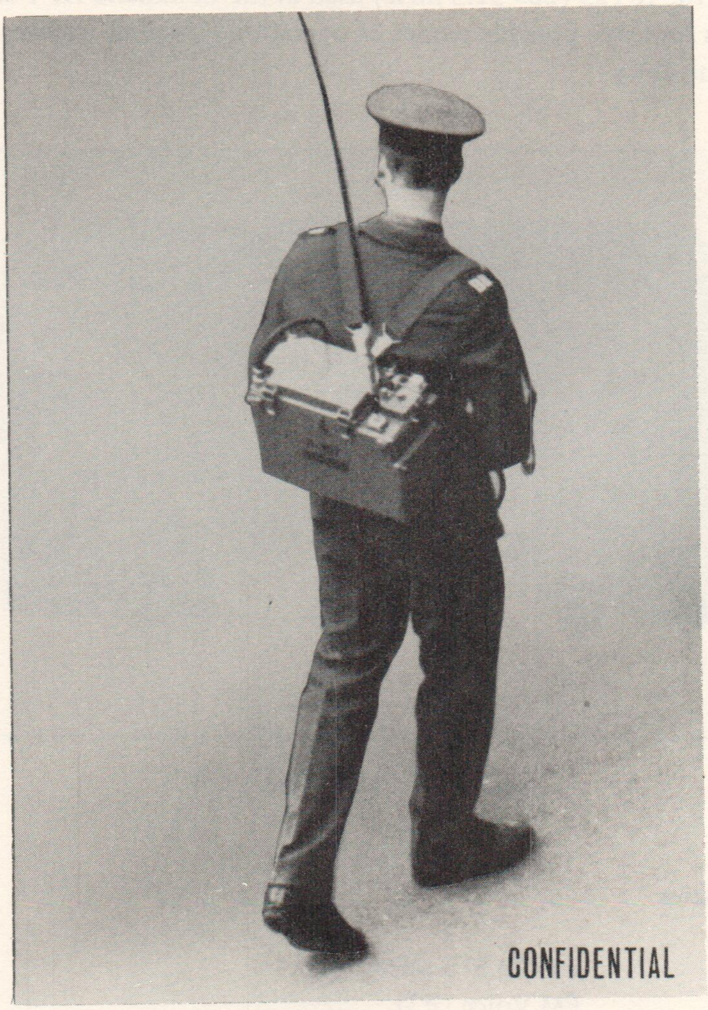

Fig 4. R-107 FM Manpack Radio Set

Technical Characteristics

Frequency Range:	20–52 MHz (Two Bands)
Mode of operation:	Voice (F3)
Tuning:	Probably continuous with preset capability
Number of Channels:	1280 (Est)
RF Channel Spacing:	25 KHz
Power output:	Approx 2 Watts
Antenna:	Kulikov
How carried:	Manpack or vehicle

Vehicle Mounted FM Radio Sets

R-113

The R-113 (Fig 5) radio set is the primary tank set used for communication in armoured units and also for other specialised tasks. This radio set has a very narrow frequency range (approx 2.3 MHz) when compared with the R-123 (20–51.5 MHz) used in the Command AFV's. A three position selector switch allows for three possible modes of operation (transmit-receive, receive only, and voice-operated transmission).

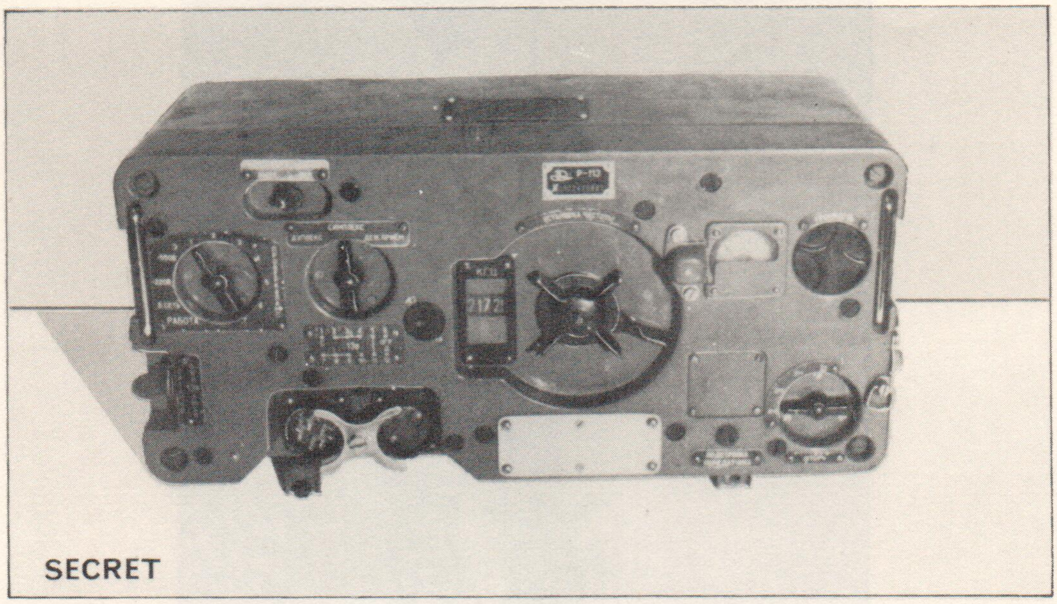

Fig 5. R-113 FM Radio Set

Technical Characteristics

Frequency Range:	20–22.375 MHz
Mode of Operation:	FM Voice (F3)
Tuning:	detent
Number of Channels:	96
RF Channel Spacing:	25 KHz
Power Output:	17 Watts
Antenna:	Whip
How carried:	Vehicle mounted (Non-Command AFV)

R-123

The R-123 (Fig 6) radio set has replaced the R-113 as the primary FM radio set mounted in the Command armoured fighting vehicles. This radio is capable of communicating with the R-105M family, the R-107 (less 51.5–52.0 MHz) and the R-113. The operating distance when stationary is about 50–60 KM and when in motion about 20 KM. It is believed the R-113 will remain the primary vehicle mounted FM set for older non-command AFVs and the R-123 will probably be the standard set for AFVs now being produced.

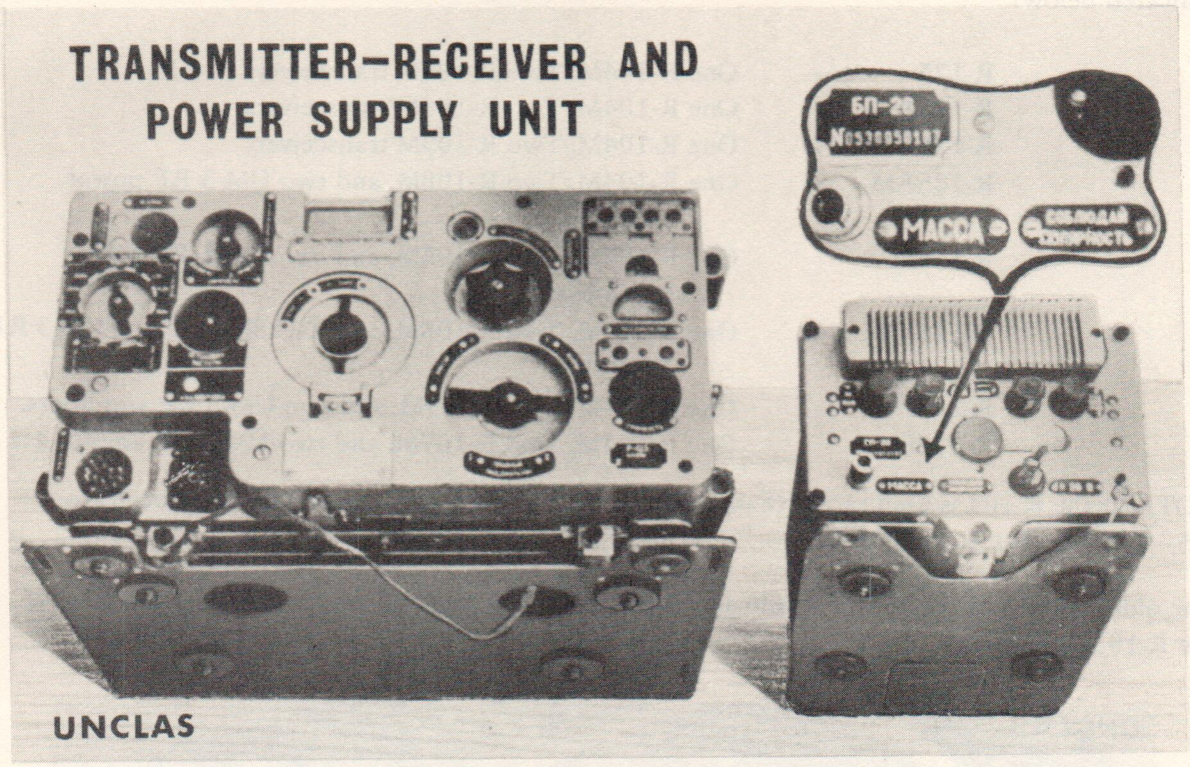

Fig 6. R-123 FM Radio Set

Technical Characteristics

Frequency Range:	20–51.5 MHz
Mode of Operation:	FM Voice (F3)
Tuning:	detent
Number of Channels:	1261
RF Channel Spacing:	25 KHz
Power Output:	17 Watts
Antenna:	Whip
How carried:	Vehicle Mounted (Command AFV)

R-125

The R-125 (Fig 7) is used to provide HF and VHF communications to regimental and battalion Commanders for command and control purposes. This radio set consists of an R-104M and either one or two R-105M, R-108M, R-109M or R-114M transceivers. When one VHF set is used an RF amplifier either the UM-1 or UM-3 is installed. If the UM-1 RF amplifier is installed only one of the VHF transceivers is used because of space limitations. When the UM-3 RF amplifier is used two VHF transceivers could be installed. Various versions of the R-125 HF/VHF radio set are as indicated below:

R-125 – One R-104M, Two R-105M transceivers
R-125A – One R-104M, Two R-108M transceivers
R-125B – One R-104M, Two R-109M transceivers
R-125AM – One R-104M, Two R-108M, and two UM-3 RF power amplifiers.
R-125M – One R-104M, Two R-105M, and two UM-3 RF power amplifiers.
R-125MT – One R-104M, Two R-105M, one R-123M, and one UM-3 RF amplifier.
R-125P – One R-104M, One R-109M, and two UM-3 RF amplifiers.
R-125PM – One R-104M, Two R-109M, and two UM-3 RF amplifiers.

NOTE: If the R-104 is used rather than the R-104M, the frequency range will be reduced from 1.5–4.5 MHz to 1.5–3.75 MHz.

The older models of the R-105 family are larger in size but the frequency ranges are the same as the R-105M family.

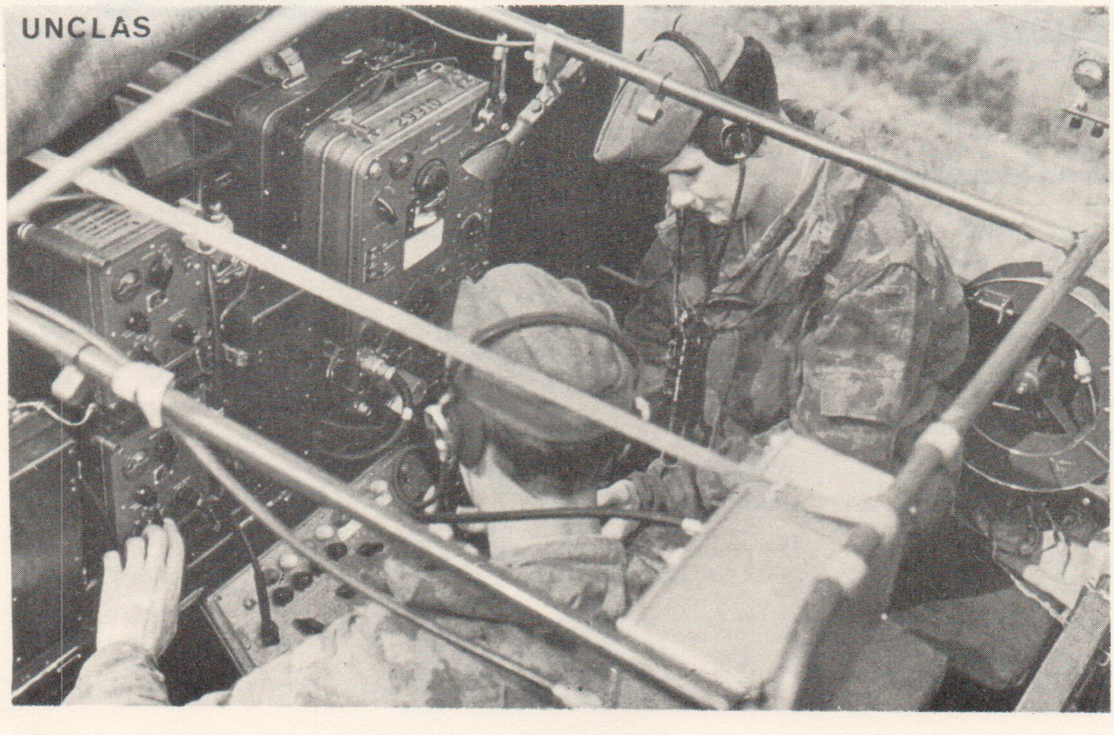

Fig 7. R-125M FM/AM Radio Set

R-125

Technical Characteristics

Frequency Range:	HF–R-104M 1.5–4.5 MHz FM–R-105M Family, depending on type of radio installed.
Mode of Operation:	R-104M – CW(A-1), MCW(A-2), Voice (A-3) R-105M Family – Voice (F3).
Tuning:	R-104M – Continuous R-105M Family – Continuous.
Number of RF Channels:	R-104M – 275 R-105M Family – Depends on type or radio used.
Power Output:	R-104M – 1–20 Watts, depending on Mode of Operation R-105M Family – Approx 2 Watts. With amplifier UM-1, 20 Watts, with amplifier UM-2, 10 Watts, with amplifier UM-3, 40–50 Watts.
Antenna:	Whip for both radios when mobile. Dipole and Kulikov on tall mast when stationary.

CONCLUSION

The FM radio sets described above are those currently held by the Soviet Armed Forces and are fully capable of providing adequate communications at the lower level of command. The manpack radios are well constructed but are heavy according to Western standards. The more recently introduced sets (eg R-107) have transistorised components and a greater frequency coverage than the older R-105 family. The R-107 will probably replace the R-105 family, however, the transition period will follow normal Soviet practice and may cover several years.

5. SA-7 LOW ALTITUDE SAM (SECRET AUSCANUKUS)

INTRODUCTION

This article updates the report on the SA-7 system published in ATIR Supplement No 101 dated July 1972 and includes additional information and photography obtained from the exploitation of equipment captured in Vietnam.

SA-7 is a man portable, infra red homing, surface to air missile system similar in concept to the American RED EYE Weapon.

The system was first firmly identified in Egypt in 1969 where it was fired operationally but with little success against high speed jet aircraft.

SA-7 next appeared in Vietnam in April 1972 where it met with considerable initial success against slower fixed wing aircraft and helicopters. In the three months following its introduction, some 286 firings were observed resulting in 26 American and South Vietnamese aircraft being hit, of which 23 were forced down or crashed. However since this time the introduction of countermeasures significantly reduced the loss rate particularly to helicopters.

Since the deployment of SA-7 to Vietnam some two dozen systems have been captured, and it is on this equipment that the technical description is based.

In November 1972 a photograph (Fig 1) was published in the Hungarian Army newspaper showing a soldier holding what is considered to be a training version of a SA-7 launcher, sitting on the back of a BMP, and this and other evidence indicates that the man portable SA-7 system is deployed in Warsaw Pact Armies.

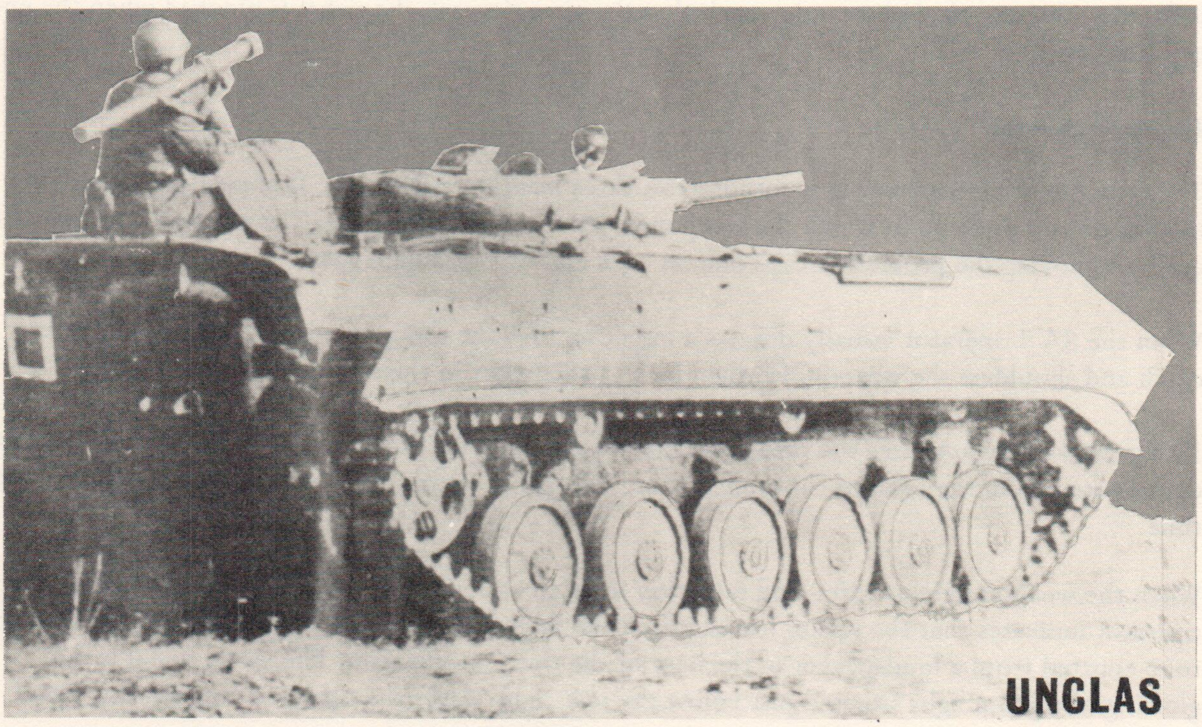

Fig 1. SA-7 Seen in Hungary

SYSTEM DESCRIPTION

SA-7 LAUNCHER

The SA-7 launcher (Fig 2) is 1.4 m long and weighs 13.4 Kg when loaded with the GRAIL missile. The smooth bore fibre glass launch tube is fitted with folding optical sights, and a detachable firing mechanism and battery assembly.

The launch tube in which the missile is sealed in order to protect it from damage, is a one shot device which is discarded after the missile has been fired.

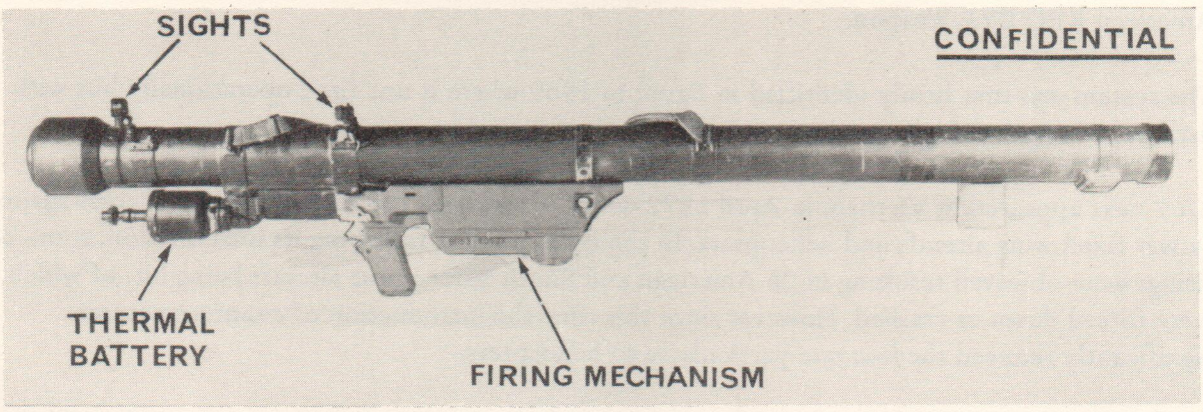

Fig 2. SA-7 Launcher

Sights

The sights are of a simple design and construction. The front sight is laterally adjustable and consists of two concentric circles. The rear sight is a simple circular aperture. The sights are 28 cms apart and the rear sight is about 15 cm from the position of the eye. The forward launcher end cap is fitted with an optical obstruction such that the view through the sights is blocked when the end cap is in position.

Firing Mechanism

The reusable firing mechanism incorporates a three position trigger, the first position being the normal or safe position in which the weapon is carried when not in use. The weapon is prepared for use by removing the protection caps one on each end of the launch tube.

When the SA-7 operator visually detects a target he fires the thermal battery, releases the safety catch and shoulders the weapon. He then locates the target in the sights and starts tracking.

Firing the battery activates the firing mechanism and supplies electrical energy for the gyro drive coils contained in the head of the launch tube. The gyro requires less than three seconds activation time.

When the weapon detects Infra Red radiation from the target an audible and visual signal to the operator indicates that the seeker has acquired the target. The audible signal consists of a 1200 Hz tone emitted from a loudspeaker in the base of the firing mechanism. The visual signal is the glowing of a green light situated just below the rear sight. After the operator receives this signal and determines that the target is within range, he pulls the firing trigger to position two. When sufficient signal strength is available, the audible signal will settle to a 100 Hz tone and the green light will burn at maximum brilliance.

The operator then fires the missile by pulling the trigger fully back to position three. This withdraws a locking pin from the missile and completes an electrical circuit which initiates the firing squib in the rocket motor.

Thermal Battery

The launcher is powered by a thermal battery which supplies power for spinning up and maintaining the rotation of the missile hominghead gyro via electrical coils situated in the front of the launch tube. Thermal battery power is also supplied to the missile electronics.

The battery is a self contained unit which is plugged and clamped into a receptacle type adapter on the launcher. It is activated by turning the knob which extends out of the battery housing. This rotates a rod, releasing a spring loaded plunger that fires a detonator. The heat from the detonator fuses the electrolyte, rendering it conductive. The output reaches a maximum of about 42 volts in less than 0.5 seconds, and is sufficient to support the system for about 60 seconds.

GRAIL MISSILE

The SA-7 missile GRAIL (Fig 3) is about 1.3 m long, 7 cm in diameter and weighs 9.2 Kg. It is stabilised by four tail mounted spring out fins and controlled by two forward spring out canard control fins.

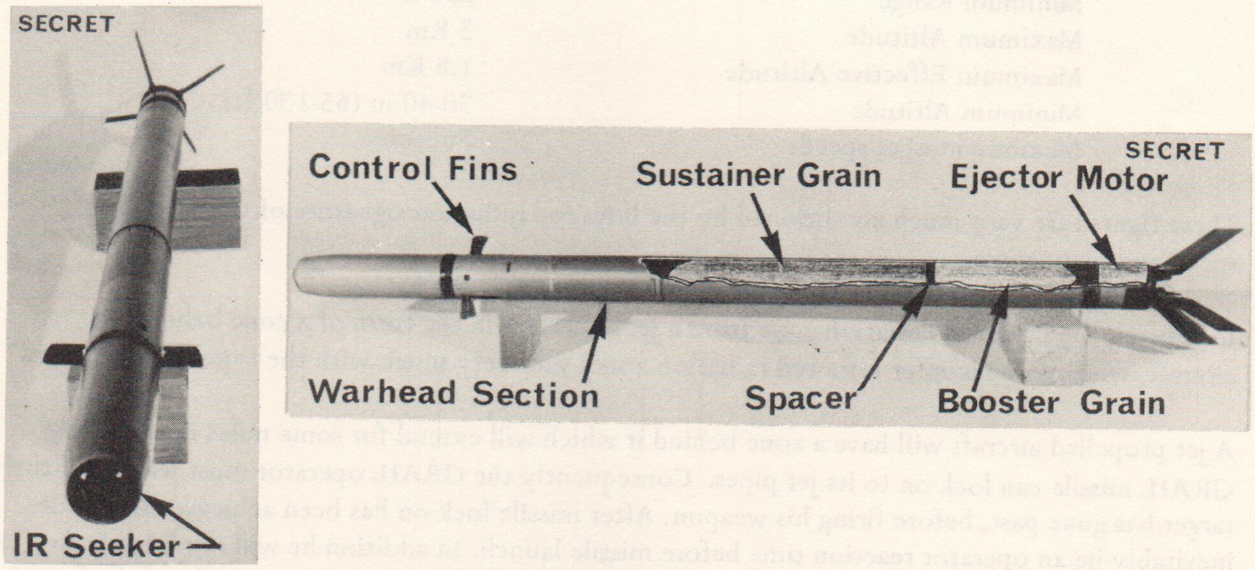

Fig 3. SA-7 Missile GRAIL

GRAIL employs infra-red passive guidance in that it homes in onto a heat source on the aircraft. The sensitive portion of the seeker is an uncooled lead sulphide detector centred on a wavelength of about 2 microns, which responds to fairly high temperature sources such as aircraft jet pipes. This detector is mounted on a gyro stabilised platform which follows the target in elevation and azimuth. The motion of this platform is transmitted electrically and processed in the guidance electronics which generate control demands to the fins in order to turn the missile in the appropriate direction.

Warhead

The warhead consists of one pound of RDX and aluminium powder with a wax bonder. The fuzing circuit is armed by a combination of time and acceleration after launch. GRAIL is equipped with a glancing fuze and a two speed impact fuze. It is designed to allow for warhead penetration of the target skin before detonation, there being no proximity fuze.

Propulsion

There are three stages of motor. The ejector motor is the first to fire. This motor exhausts through four small nozzles and only burns while the rear end of the missile is within the launch tube. It gives the missile sufficient speed so that it will glide to a safe distance from the operator before the main motor fires. The main motor consists of a booster and a sustainer in the same combustion chamber which is a novel feature of the propulsion system. This motor exhausts through a single central nozzle and supplies two seconds of boost and six seconds of sustainer burn, resulting in a missile velocity of 490 m/sec. For storage in the launch tube all aerodynamic surfaces fold neatly.

SYSTEM PERFORMANCE AND LIMITATIONS

Maximum Range	4 Km
Minimum Range	600 m
Maximum Altitude	3 Km
Maximum Effective Altitude	1.8 Km
Minimum Altitude	20-40 m (65-130 ft)
Maximum target speed	Subsonic

These figures are very much conditioned by the infra red radiation signature of the target, its speed and manoeuvre.

In general, the infra red radiation zone from a jet aircraft is in the form of a cone behind the aircraft, where as helicopter infra red radiation zones vary very much with the type of helicopter.

A jet propelled aircraft will have a zone behind it which will extend for some miles in which the GRAIL missile can lock on to its jet pipes. Consequently the GRAIL operator must wait until the target has gone past, before firing his weapon. After missile lock on has been achieved there will inevitably be an operator reaction time before missile launch. In addition he will not be able to follow targets which have an angular rate greater than about 10° per second. A study of the launch and hit zones based on these considerations shows that the faster and higher an aircraft flies, the safer it will be from SA-7 attack.

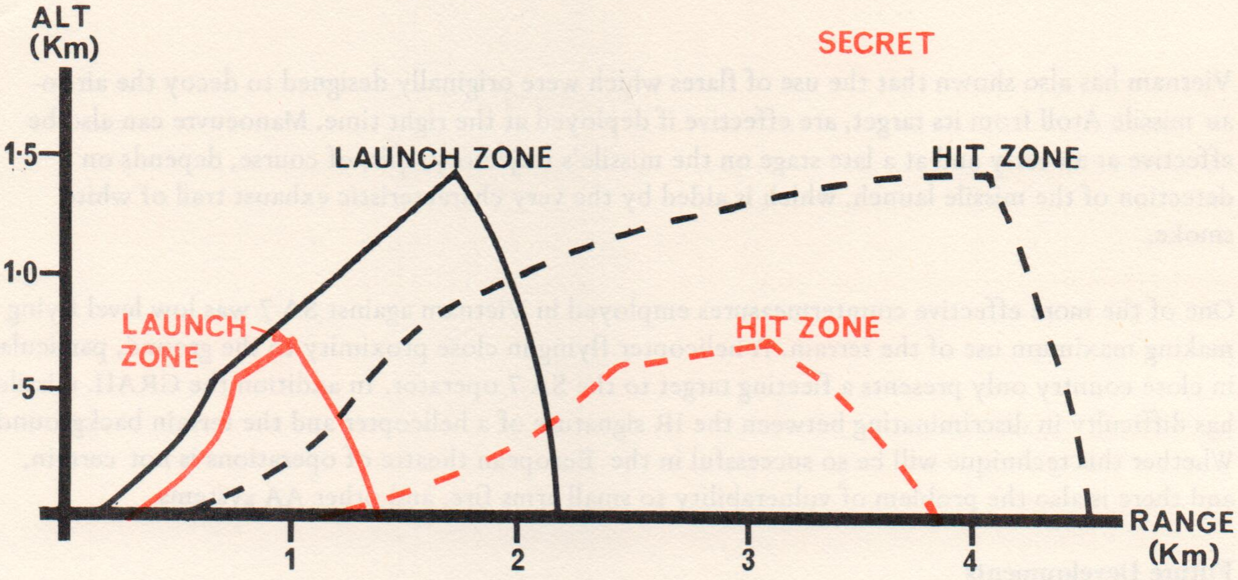

Fig 4. SA-7 Cover Diagram (Vertical)
(NB 150 m/sec lines in black)
225 m/sec lines in red)

The result of a two dimensional simulation of system performance against typical targets flying at 150 m/sec and at 225 m/sec is shown in Fig 4. It can be seen that an increase in target speed results in a decrease in the maximum effective altitude and capability of the system.

The minimum effective altitude is difficult to define because it will depend on many factors such as the infra red background and low angle of elevation which will vary with the circumstances, and also the missile's deviations from its ideal trajectory which are not fully known yet.

A study of some practical results from the early part of the use of SA-7s in Vietnam bears out the performance analysis which has just been outlined. No target was hit when flying at speeds above 175 m/sec or at altitudes greater than 1.8 Km (6000 ft).

It has been confirmed that the GRAIL missile has a capability to home on sunlight specular reflection. The missile seeker utilises in addition to other heat sources, solar energy reflected from the aircraft. This ability to track reflected solar energy also has its problems in that for targets with a low signature the seeker can be confused by other sources such as bright cloud edges.

The small warhead also has its disadvatanges. There have been several cases reported of aircraft being hit, the missile warhead exploding, but the aircraft returning safely to base. Nevertheless the warhead has proved lethal against helicopters and smaller fixed wing aircraft.

SYSTEM COUNTERMEASURES

There are several countermeasures which if employed afford some protection from SA-7. The obvious one which was tried with some success in Vietnam was the shielding of sources of infra red radiation on the target. For example on helicopters, jet exhausts have been protected by baffles and by redirecting the exhaust upwards, and other heat sources such as oil cooler vents have been shielded. The application of non infra red reflective paint to aircraft surfaces reduces the reflected solar energy and decreases the tracking ability of the missile.

Vietnam has also shown that the use of flares which were originally designed to decoy the air-to-air missile Atoll from its target, are effective if deployed at the right time. Manoeuvre can also be effective at an early and at a late stage on the missile's trajectory, this, of course, depends on detection of the missile launch, which is aided by the very characteristic exhaust trail of white smoke.

One of the more effective countermeasures employed in Vietnam against SA-7 was low level flying making maximum use of the terrain. A helicopter flying in close proximity to the ground, particularly in close country only presents a fleeting target to the SA-7 operator. In addition the GRAIL missile has difficulty in discriminating between the IR signature of a helicopter and the terrain background. Whether this technique will be so successful in the European theatre of operations is not certain, and there is also the problem of vulnerability to small arms fire, and other AA systems.

Future Developments

The current known version of SA-7 has proved effective against slower low flying piston engined aircraft and helicopters but has not been successful against the faster flying jet aircraft. However the basic system has considerable development potential. Homing head cooling would increase the sensitivity of the GRAIL missile and make it respond to lower temperature sources. Improved propulsion and control would increase missile range and engagable target speed. Development along these lines would greatly increase the threat posed by the system.

BRDM-2 SAM SYSTEM

INTRODUCTION

The identification of the SA-7 system in Vietnam led to speculation that a vehicle mounted system based on SA-7 was a possibility, and would be particularly attractive to the Warsaw Pact Armies. Information from a number of sources confirmed that such a system was being developed and it is now being seen deployed in GSFG and elsewhere.

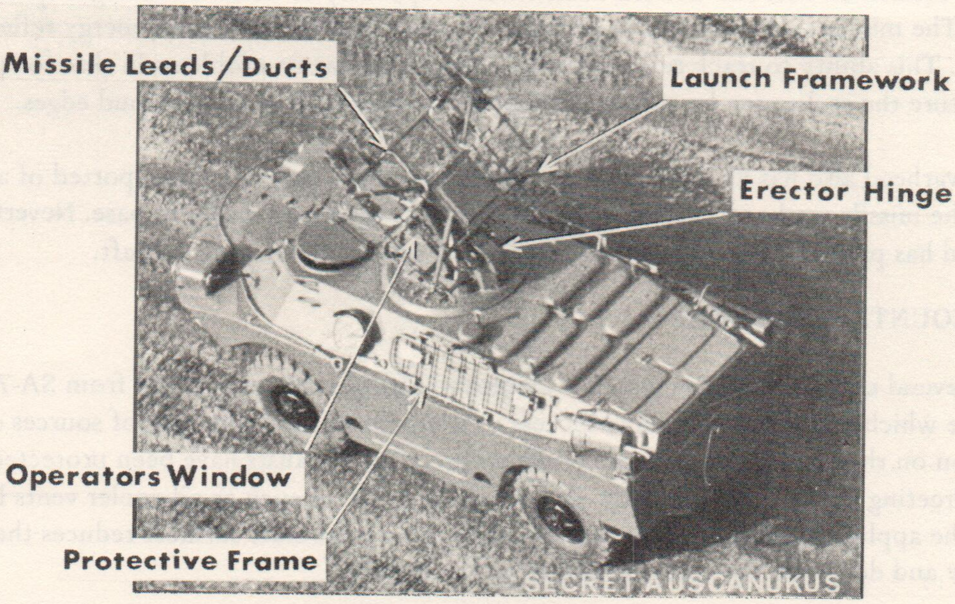

Fig 5. BRDM-2 SAM Operating Mode

SYSTEM DESCRIPTION

The system is mounted on a modified BRDM-2. (Fig 5)

The standard BRDM-2 turret has been replaced by a pedestal upon which the missile mounting framework is fitted. The complete assembly rotates through 360° within what appears to be the standard turret ring.

There is a rectangular window in the forward base of the pedestal mounting which rotates with it and through which the operator views the target. No optical device has so far been identified to assist in acquisition and tracking.

At the rear of the pedestal is an erector hinge which elevates the whole launch assembly from the travelling position (Fig 6) to the operating position. There is a further hinge which enables the framework to which the missile canisters are attached to be elevated or depressed.

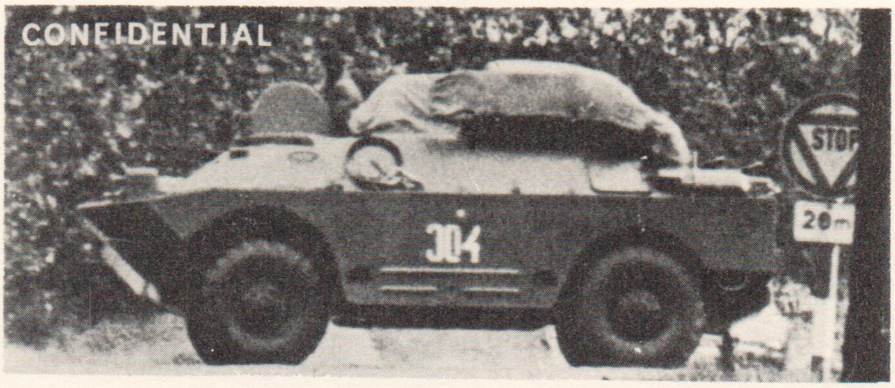

Fig 6. BRDM-2 SAM Travelling Mode

Protective frames situated on each side of the BRDM-2 towards the rear of the hull are used in the travelling position to protect the missile canisters. These frames fold down over the hull chamfer when the missile framework is elevated in the operating position.

At the time of writing the missile canisters have not been seen. It is thought that these GRAIL missile canisters are slung under the missile launch framework in the operating position, and rotate with the framework so that they rest on top of it in the travelling position. There would seem to be room for up to four missile canisters to be attached to the launch frame giving a possible maximum of 4 or 8 missiles depending on the number of missiles in the canister.

Probable missile firing leads can be seen although there is speculation due to their thickness as to whether they could be coolant ducts for homing head cooling indicating an improved version of GRAIL. However there is no firm evidence at present to suggest that the missiles are anything other than the standard GRAIL missile.

SYSTEM ADVANTAGES

The main advantages of the vehicle mounted system apart from the additional mobility would appear to be better protection for the operator, the ability for the vehicle to operate in an NBC environment, improved command and control over the vehicle's radio and the possibility of salvo fire.